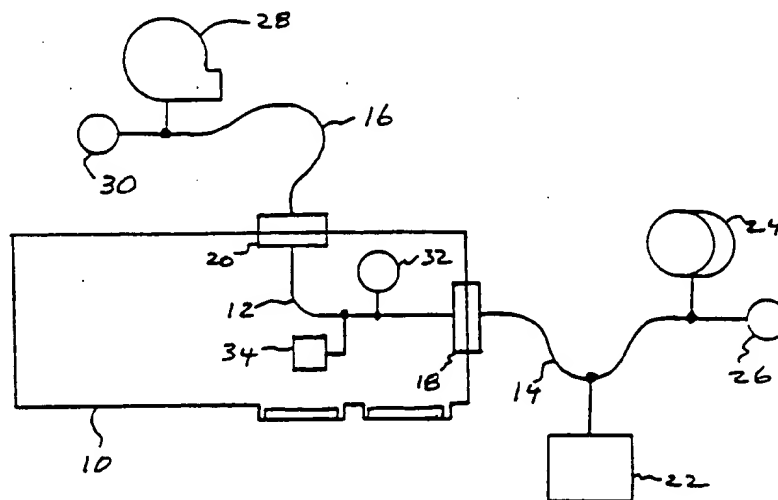




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(54) Title: AUTOMATIC DISABLING OF TERMINATION OF A DIGITAL COMPUTER BUS



(57) Abstract

A method of disabling active termination on an SCSI device when the SCSI device is not at the terminal end of the SCSI bus chain, and circuitry for accomplishing that method. An SCSI device has selectable active termination. When the SCSI device is off, the active termination circuitry is powered by the termination power line of the SCSI bus, and so the termination circuitry does not require power to the SCSI device to work properly. The SCSI device has two ports for connection in the SCSI chain, and the SCSI device detects whether a device is present on each of those ports by detecting whether a line that pulled to ground has in fact been pulled to ground. If both ports are connected to SCSI device, then the SCSI device disables its active termination using the disconnect input of the circuit it uses for active termination of the SCSI bus. Further, the SCSI device can communicate whether devices are connected to each of its SCSI ports to a host computer system via the system bus.

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TITLE: AUTOMATIC DISABLING OF TERMINATION OF A
DIGITAL COMPUTER BUS

SPECIFICATION

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

5 The invention relates to termination of digital computer busing systems, and more particularly, to a method of and circuitry for automatically enabling and disabling active termination of a bus used by a digital computer system.

2. DESCRIPTION OF THE RELATED ART

10 Digital computer systems are becoming more powerful, flexible, and distributed with each passing day. These advances are due to many factors, including improvements in software capabilities, in computer system architectures, and in semiconductor devices such as microprocessor and memory chips.

15 One architecture that has often improved the flexibility and performance of small systems is the Small Computer System Interface (SCSI) standard. The SCSI standard is a specification developed by the American National Standards Institute (ANSI) defining mechanical, electrical, and functional requirements for
20 attaching small computers to each other and to intelligent peripherals such as hard disks, flexible disks, magnetic tape drives, printers, optical disks, and scanners. The current issued specification is SCSI-2, with SCSI-3 under development. The SCSI-2
25 specification, either the final or most recently

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published draft, is incorporated into this document by reference.

One advantage of SCSI is that numerous devices can be connected on a single bus and accessed through a single controller, with only software device drivers varying between the devices. This facilitates the connection of new devices to the bus. By allowing the combination of a variety of devices on a single standardized bus, SCSI provides a very flexible system. A second advantage of SCSI is its high performance. A system implementing SCSI can quickly and efficiently communicate with very high density storage devices.

Because of SCSI's high performance capabilities and its expanding popularity, chip designers have developed specialized integrated circuits to implement many parts of the SCSI standard. Some of these chips handle many of the low level complexities of interfacing the physical portion of the SCSI standard, which is the physical connection between the controller and the various devices. One example of such a chip is the 53C710 SCSI I/O Processor from NCR Corporation (NCR) of Dayton, Ohio. This device would typically be implemented on a circuit board for use as a SCSI controller card. Such a controller card typically would physically run on a host computer system bus, such as the EISA bus, and would also provide the physical connectors for connecting to the SCSI bus. The controller chip would then interface between the host system bus and the SCSI bus.

An inconvenience of the SCSI standard is its requirement that the ends of the SCSI bus be terminated. The SCSI bus is a linear rather than a ring bus, and certain signals on the bus must be terminated at each physical end of the bus. Such a need for termination is common in bus driven system

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while passive termination is commonly used on the SCSI bus, particularly for external units, active termination has numerous advantages. To simplify the use of active termination, specific chips for providing this active termination have been developed for the SCSI bus. An example of such a chip is the UC5601 SCSI Active Terminator, made by Unitrode. Certain devices on the SCSI bus, called initiators, are required to provide terminator power to the ends of the SCSI bus chain via a line on the SCSI bus referred to as TERMPWR. The devices at the SCSI bus ends are then configured to provide the termination either using their own power supply or by using TERMPWR.

This termination requirement, however, causes a problem when attaching additional devices to the SCSI bus. As the last device in the chain is already terminating the SCSI bus, the addition of another device to the chain will place the terminating device in the middle of the SCSI chain. This is not allowed.

In the past, SCSI devices have generally had physical switches to switch their termination in or out or have even required the user physically open the device and remove a resistor network or other source of termination. This is not only physically inconvenient, but also a potential pitfall for the novice user. A new user may not know to disable the termination on a device at the middle of the SCSI chain, and this lack of knowledge could result in a improperly terminated SCSI bus, leading to performance degradation or failure of the SCSI bus and devices upon it. Further, termination typically requires around 430mA, and the TERMPWR signal is only rated for two such terminations, so excessive termination can result in overloading of the TERMPWR line.

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It is often desirable to use a SCSI system in which not all devices are physically turned on. In such a case, it is still desirable for the device at the end of the chain, even if turned off, to provide the termination required by the SCSI standard.

Finally, a SCSI device or controller often needs to know if other devices are physically located along the SCSI chain in each direction.

It would be desirable for a SCSI device or controller to automatically detect when it is not the last device on the SCSI chain, and if so, to automatically disable termination that location, even if that device or controller is physically turned off.

SUMMARY OF THE INVENTION

A SCSI controller built according to the invention, or used according to the method of the invention, detects the presence of other SCSI devices both up and down the SCSI chain. If such a device is not present, then the SCSI controller actively terminates the bus, as it is at the end of the chain. If, however, SCSI devices are present both up and down the SCSI chain, the SCSI controller according to the invention disables its active termination. The SCSI controller performs this function whether it is turned on or off.

A SCSI controller built according to the invention can also logically sense whether devices are present up and down the SCSI chain. An onboard microprocessor or the controller chip can use this information itself, or the information can be passed along to the host computer via a system bus.

A SCSI controller built according to the invention determines if a device is present further along the SCSI chain by sensing whether a certain pin that the

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SCSI standard specifies is to be grounded is actually grounded. If it is not, then there are no further devices along that end of the SCSI chain; if the line is grounded, then there must be a device further along that end of the SCSI chain pulling that line to ground. 5 The controller according to the invention senses the presence of other devices in both directions along the SCSI chain; as the controller has at least two ports for the SCSI bus, it separately senses whether devices are present further along from the first port and from 10 the second port by sensing whether the particular line is in fact grounded for each port.

The device according to the invention does this by pulling up the normally grounded line through a pull up resistor. If a device is present and the line is thus 15 in fact grounded, that line is pulled down. The line provides the switching signal for a transistor, so when the line is pulled down, this turns the transistor off; if the transistors connected to the ground lines both up and down the SCSI chain are turned off, then the 20 outputs, which are tied together, are pulled high. This state indicates that the controller is in the middle of the SCSI chain and need not actively terminate the bus. This high signal then disables a SCSI terminator chip on the controller. 25

Power for these functions is provided by the signal TERMPWR when the system is turned off, so that the termination switching properly functions whether or not the controller according to the invention is turned 30 on.

Further, according to the invention, if it is desired that the SCSI controller or a host system be able to logically sense whether devices are further up or down the SCSI chain, a MOSFET transistor is used to 35 allow sensing of the presence of those devices. When a

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device is present further along the SCSI bus, that line will be low; when a device is not present that line will be high. This allows the sensing by a processor of the presence of devices further up or down the SCSI bus. Then, the signal provided to the gate of the MOSFET transistor is sensed and transmitted to the controller's processor or to the host system via an I/O port.

10 A better understanding of the invention can be obtained when the following description of the preferred embodiment is considered in conjunction with the following drawings, in which:

15 Figure 1 is a block diagram showing a SCSI controller built according to the invention connected in the middle of the SCSI chain;

 Figure 2 is a block diagram of a second SCSI controller built according to the invention with provisions for occupying two nodes in the SCSI chain;

20 Figures 3A and 3B are a schematic of a circuit used to automatically enable and disable active termination by the SCSI controller shown in Figure 1 according to the invention;

25 Figure 4 is a schematic of a circuit used to automatically enable and disable active termination in the internal node of the second SCSI controller shown in Figure 2 according to the invention; and

30 Figures 5A and 5B are a schematic of a circuit used to automatically enable and disable active termination in the external node of the second SCSI controller shown in Figure 2 according to the invention.

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Turning to the drawings, Figure 1 shows a SCSI controller 10 connected in the middle of the SCSI chain. The SCSI controller 10 has an internal SCSI bus 12 with physical connectors for connection with an external leg 14 of the SCSI bus and an internal leg 16 of the SCSI bus. The internal SCSI bus 12 connects to the external leg 14 via an external SCSI port 18. Similarly, the internal SCSI bus 12 connects to the internal leg 16 via an internal SCSI port 20. The external leg 14 is typically external to the device within which the SCSI controller 10 is housed. Conversely, the internal leg 16 is typically housed within the device in which the SCSI controller 10 is housed.

On the external leg 14 are shown a first external SCSI device 22 and a second external SCSI device 24. These could be any of the numerous types of SCSI devices. Also shown connected to the end of the external leg 14 is an external terminator 26. In actual practice, the external terminator 26 may be a part of the second external SCSI device 24 or may be an external terminator plug.

On the internal leg 16 is shown an internal SCSI device 28 and an internal terminator 30. Here the internal terminator 30 is typically physically part of the internal SCSI device 28. The internal SCSI device 28 also is normally housed within the same physical device as is the SCSI controller 10.

An active SCSI terminator 32 connected to the internal SCSI bus 12 is shown on the SCSI controller 10. Also shown on the SCSI controller 10 is a controller chip 34. The controller chip 34 could be a variety of devices, including the 53C710 by NCR. The SCSI terminator 32 could be either discrete or

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integrated circuitry; in the preferred embodiment, the SCSI terminator 32 is the UC5601 by Unitrode.

In use, the SCSI terminator 32 on the SCSI controller 10 is active unless both the external leg 14 and the internal leg 16 are connected to the internal SCSI bus 12. In such a case, the SCSI controller 10 is not the terminal device on either end of the SCSI chain, so no termination is needed or even allowed. Further, the SCSI terminator 32 is enabled and disabled properly whether the SCSI controller 10 is powered or not. The SCSI terminator 32 is automatically enabled and disabled by circuitry to be described in the discussion of Figures 3A and 3B.

Figure 2 shows a second SCSI controller 100. The second SCSI controller 100 has two nodes for connection to the SCSI bus, an external SCSI node 102 and an internal SCSI node 104. The external SCSI node 102 connects to the external leg 14 via the external SCSI port 18. The external leg 14 has on it the external terminator 26 and an external SCSI device 106.

The internal node 104 is connected to a nose leg 108 via a nose SCSI port 110. On the nose leg 108 is a nose terminator 112 and a nose SCSI device 114. Again, the nose terminator 112 is usually a physical part of the nose SCSI device 114. This nose SCSI device 114 can be a device such as a tape drive, and it can be located within the same physical device as the second SCSI controller 100, but located in an area or nose of the computer allowing access to removable media, unlike hard disk drives which do not require normal access. The external SCSI node 102 and the internal SCSI node 104 are also connected to a two-ended internal leg 116. The external SCSI node 102 is connected to the two-ended internal leg 116 through an internal SCSI port out 118, and the internal SCSI node 104 is connected to the

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two-ended internal leg 116 through an internal SCSI port in 120. On this two-ended internal leg 116 are connected internal SCSI devices 122. The internal SCSI devices 122 can be, for example, a stack of hard disk drives physically located inside the same physical box as the second SCSI controller 100 and the nose SCSI device 114.

An external active SCSI terminator 124 and the controller chip 10 are electrically connected to the external SCSI node 102. The external SCSI terminator 124 remains functional whether or not the SCSI controller 100 has power; unless both the external leg 14 with its SCSI devices and the two-ended internal leg 116 with its SCSI devices are connected to the second SCSI controller 100, the external SCSI terminator 124 remains enabled and active.

Similarly, an internal active SCSI terminator 126 is connected to the internal SCSI node 104. The internal SCSI terminator 126 is always active, even when the second SCSI controller 100 has no power, unless both the nose leg 108 and the two-ended internal leg 116 are present and have attached devices.

The external SCSI terminator 124 and the internal SCSI terminator 126 can be a variety of devices, such as a UC5601 by Unitrode. The circuitry for enabling and disabling the internal SCSI terminator 126 is shown in Figure 4 and described later. Similarly, the circuitry for enabling and disabling the external SCSI port terminator 124 is shown in Figures 5A and 5B and described later.

The controller chip 10 on the second SCSI controller 100 can sense when devices are connected to the SCSI bus via external SCSI port 18, internal SCSI port out 118, internal SCSI port in 120, and nose SCSI

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port 110. The circuitry for this detection is shown in Figures 4, 5A and 5B and is described later.

The second SCSI controller 100 also has connectors 126 for connection to and communication with a host computer system bus, such as an EISA bus.

The second SCSI controller 100 has a number of convenient features. First, of course, all of its on-board termination is automatic. Second, however, the internal SCSI devices 122 can be added to the bus without checking to see if they end the SCSI chain; as they are connected to the second SCSI controller 100 on both ends, they will never need termination as it is handled by the second SCSI controller 100.

Figures 3A and 3B show a circuit to be used in the SCSI controller 10 to enable and disable SCSI termination based on the presence or absence of devices up and down the SCSI bus chain. Figures 3A and 3B show the external SCSI port 18 and the internal SCSI port 20 connected to the various signals of the internal SCSI bus 12. Although the pinouts of the external SCSI port 18 and the internal SCSI port 10 are different, this results from use of alternative connectors allowed under the SCSI standard.

Of note is the EXTEN* signal connected to the external SCSI port 18 and the INTEN* signal connected to the internal SCSI port 20. These signals are connected to pins that the SCSI standard specifies should be pulled low. Thus, when a device is connected to the external SCSI port 18, that device will pull the EXTEN* signal low; otherwise, the EXTEN* signal usually floats. Similarly, when a device is connected to the internal SCSI port 20, it pulls the INTEN* signal low; otherwise, that signal also usually floats. In Figures 3A and 3B, the INTEN* signal is pulled high by a pull-up resistor 300, and the EXTEN* signal is pulled high

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by a pull-up resistor 302. Pull-up resistors 300 and 302 are typically 4.7K ohms.

The pull-up resistors 300 and 302 are pulled up by TERMPWR, the termination power supply provided by initiator devices on the SCSI bus. As can be seen, TERMPWR is connected to the internal SCSI port 20 and the external SCSI port 18. As the circuitry of Figures 3A and 3B is located on the SCSI controller 10, and a SCSI controller is always an initiator device, the SCSI controller 10 provides TERMPWR if it is turned on, in which case TERMPWR is provided through a rectifier diode 304, which is connected to TERMPWR through resettable breakers 306.

If the SCSI controller 10 is not turned on, then TERMPWR is provided by another initiator device via the internal SCSI port 20 or the external SCSI port 18. In that case, the rectifier diode 304 prevents power from leaking back into the SCSI controller 10. If there is no other initiator device on the SCSI bus, then TERMPWR will not be supplied anywhere, but that case does not matter, as if there is no initiator device the SCSI bus cannot operate.

The signal INTEN* is connected to a filter capacitor 310 and also drives the base of an internal bipolar transistor 308. The other side of the filter capacitor 310 is connected to ground, as is the emitter of the internal bipolar transistor 308. Similarly, the signal EXTEN* is connected to a filter capacitor 312 and also drives the base of an external bipolar transistor 314. Again, the emitter of the external bipolar transistor 314, as well as the other side of the filter capacitor 312, is connected to ground. The collectors of the external bipolar transistor 314 and the internal bipolar transistor 308 are pulled up by TERMPWR via a pull-up resistor 316. Also, TERMPWR is

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filtered to ground with the filter capacitors 318 and 320. The transistors 308 and 314 are typically 2N2222 transistors. The filter capacitors 310, 312 and 320 are typically .1 μ F capacitors. The pull up resistor 316 is typically a 4.7K ohm resistor. Finally, the filter capacitor 318 is typically 22 μ F.

The SCSI terminator 32 is typically a UC5601, and has a disconnect input. The pulled up collectors of the transistors 314 and 308 are connected to that disconnect input DC of the SCSI terminator 32. That disconnect input is active high, and when high, the SCSI terminator no longer actively terminates the lines on the internal SCSI bus 12 that it usually actively terminates. When the disconnect input DC is low, the SCSI terminator is enabled and actively terminates the SCSI bus. On the SCSI bus, all signals require termination except RESERVED, GROUND or TERMPWR.

Whenever either transistor 308 or 314 turns on, the disconnect input DC of the SCSI terminator 32 is pulled low. As mentioned, when low, the SCSI terminator 32 provides active termination. Thus, if either the signal EXTEN* or signal INTEN* goes high, then the SCSI terminator 32 provides active termination; conversely, when the signals EXTEN* and INTEN* are both low, the SCSI terminator 32 does not actively terminate. This is consistent with the requirements of the SCSI system. EXTEN* and INTEN* will only both be low when devices are connected to both the external SCSI port and the internal SCSI port 20. In such a case, the SCSI controller would not be in the middle of the SCSI chain and so would need to turn off its active termination.

Figures 4, 5A and 5B show circuitry used on the second SCSI controller 100 to enable and disable the internal SCSI terminator 126 and the external SCSI

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terminator 124, as well as to indicate to the host system via an I/O port which SCSI ports 18, 110, 118 and 120 have devices connected.

Figure 4 shows the circuitry necessary to enable and disable the internal SCSI port terminator 126. Figure 4 shows the nose SCSI port 110 and the internal SCSI port in 120 connected to the internal SCSI node 104. Further, the ground signals of the SCSI ports 110 and 120 are connected to ground.

TERMPWR is connected to the SCSI ports 110 and 120 in a way similar to that shown in Figures 3A and 3B. TERMPWR is provided to the circuit via a rectifier diode 400 and a fuse 402. When the second SCSI controller 100 is turned off, TERMPWR is provided by other SCSI initiators via either SCSI port 110 or 120. When the second SCSI controller 100 is turned on, power flows through the rectifier diode 400 and through the fuse 402 to the signal TERMPWR. TERMPWR provides power to the internal SCSI terminator 126 and to the pull-up resistors 404, 406 and 408. TERMPWR is filtered through filter capacitors 410 and 412, and TERMPWR is also used in the circuit shown in Figures 5A and 5B. The pull-up resistors 404, 406, and 408 are typically 8.2K ohm resistors. Filter capacitors 410 and 412 are typically 22 μ F and .1 μ F respectively.

The circuitry for enabling and disabling the internal SCSI terminator 126 is similar to that as shown in Figures 3A and 3B for enabling and disabling the SCSI terminator 32. A signal NOSEN* is connected to the nose SCSI port 110, and a SCSI device present on that port will ground that signal. Similarly, the signal INTIEN*, when grounded, indicates a device is present on the internal SCSI port in 120. NOSEN* is connected to TERMPWR via the pull up resistor 406 and is connected to ground via a filter capacitor 414,

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which is typically .1 μ F. NOSEN* is also connected to the gate of a MOSFET transistor 416.

Similarly, INTIEN* is connected to TERMPWR via the pull-up resistor 404, is connected to ground via a filter capacitor 418, and is connected to the gate of a MOSFET transistor 420. The filter capacitor 418 is typically .1 μ F.

The MOSFET transistors 416 and 420 act as switches and are typically 2N7002, but other types of switches can be substituted. These devices turn on when their gates rise above a threshold voltage and turn off when their gates drop below the threshold voltage. In operation, the MOSFET transistors 416 and 420 operate in a manner similar to the external bipolar transistor 314 and the internal bipolar transistor 308 shown in Figures 3A and 3B. A difference is that when NOSEN* and INTIEN* are not grounded by devices on the nose SCSI port 110 or the internal SCSI port 120 respectively, those signals rise to the level of TERMPWR. In the comparable circuit using external bipolar transistor 314 and internal bipolar transistor 308 in Figures 3A and 3B, the comparable signals would not rise to the level of TERMPWR, because the base to emitter drop of those transistors 314 and 308 would not be over a standard diode drop, or approximately .7 volts. Here, the voltage can rise, so the signals NOSEN* and INTIEN* can be used by digital logic to indicate whether external SCSI devices are connected to nose SCSI port 110 or internal SCSI port 120.

The circuitry for providing this feature is shown in Figures 5A and 5B. Turning to that Figure it is seen that the signal NOSEN* is connected to an I/O port 500 via a rectifier diode 502. Similarly, the signal INTIEN* is connected to the I/O port 500 via a rectifier diode 504. The I/O port 500 is a typical I/O

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port, and is here implemented using an octal buffer, such as a 74LS244. The signals associated with NOSEN* and INTIEN* are pulled high with pull up resistors 506 and 508; unless NOSEN* or INTIEN* are grounded by their devices on the nose SCSI port 110 or the internal SCSI port 120, the respective signals into the I/O port 500 will be high. This I/O port 500 is connected via connectors 126 to a system bus, such as the EISA bus, and allows the a host computer to read the states of these two signals via the I/O port 500. Alternatively, this I/O port 500 can be connected to the controller chip 34.

Similar circuitry connects the I/O port 500 to the internal SCSI port out 118 and the external SCSI port 18. The internal SCSI port out 118 has a device connected if the signal INTOEN* is pulled low by that port; for external SCSI port 18, the signal is EXTEN*. Both of these signals are then provided to the I/O port 500.

As the internal SCSI port out 118 and the external SCSI port 18 are on a different node (the external SCSI node 102) than the nose SCSI port 110 and the internal SCSI port 120, the external SCSI terminator 124 must be enabled or disabled independently of the internal SCSI terminator 126. This is done by circuitry identical to that described in relation to the enabling and disabling of the internal SCSI terminator 126 as shown in Figure 4.

The foregoing disclosure and description of the invention are illustrative and explanatory only, and various changes in the size, shape, materials, components, circuit elements, wiring connections and contacts, as well as the details of the illustrated circuitry and construction method of operation may be

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made without departing from the spirit of the invention.

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CLAIMS

What is claimed is:

- 1 1. A method for automatically disabling a SCSI
2 device's active termination of a bus requiring
3 termination at both ends of the bus when the device is
4 not a terminal device on the bus, the method comprising
5 the steps of:
6 providing active termination on a first
7 device on the bus;
8 detecting if a second device is connected to
9 a first bus port on said first device;
10 detecting if a third device is connected to a
11 second bus port on said first device; and
12 if both said second device and said third
13 device are detected, disabling said active termination
14 on said first device.
- 1 2. The method of claim 1, further comprising the
2 step of:
3 allowing a host computer system to monitor
4 whether said second device is connected to said bus and
5 whether said third device is connected to said bus.
- 1 3. The method of claim 1 wherein said bus is a
2 SCSI bus and said devices are SCSI devices.
- 1 4. An apparatus on a device for selectively
2 terminating a bus, the bus requiring termination at
3 both ends and capable of receiving a plurality of
4 devices, the apparatus comprising:
5 an active terminator circuit including a
6 power input for connection to a termination power
7 signal on the bus, termination points for connection to
8 signals on the bus that require termination, and a

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9 disconnect input for enabling and disabling said
10 termination points;
11 a first port connected to said bus;
12 a second port connected to said bus;
13 means for detecting whether a device is
14 connected to said first port;
15 means for detecting whether a device is
16 connected to said second port; and
17 means connected to said active terminator
18 circuit, said means for detecting whether a device is
19 connected to said first port and said means for
20 detecting whether a device is connected to said second
21 port for providing a signal to said active terminator
22 circuit disconnect input to indicate disconnection when
23 said detecting means indicate devices are connected to
24 both said first port and said second port.

1 5. The apparatus of claim 4, wherein said first
2 port detecting means and said second port detecting
3 means both include a power input for providing power,
4 said power inputs connected to the termination power
5 bus signal on the bus.

1 6. The apparatus of claim 5, wherein said first
2 port detecting means includes a transistor having its
3 control input connected to a signal on the bus
4 designated as ground, an output connected to ground and
5 the other output connected to said active terminator
6 circuit disconnect input; a resistor connected between
7 said power input and said transistor control input and
8 a resistor connected between said power input and said
9 active terminator circuit disconnect input, and
10 wherein said second port detecting means includes
11 a transistor having its control input connected to a
12 signal on the bus designated as ground, an output

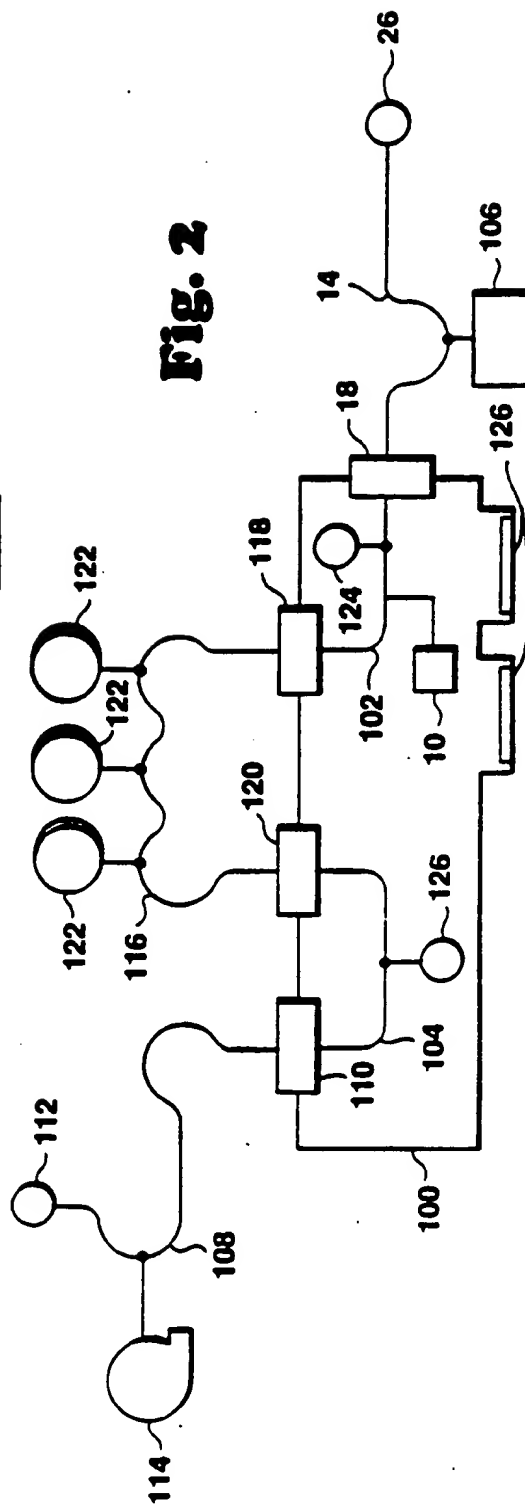
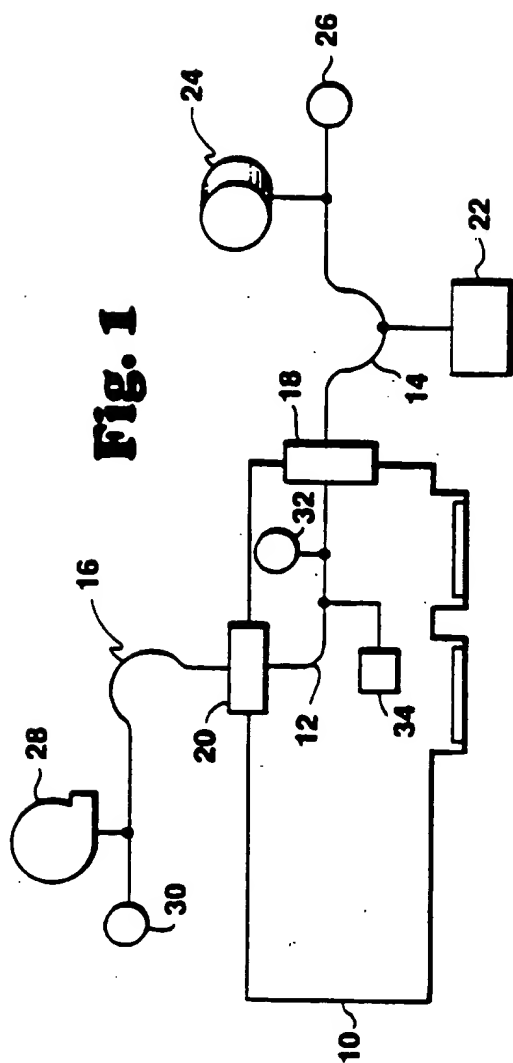
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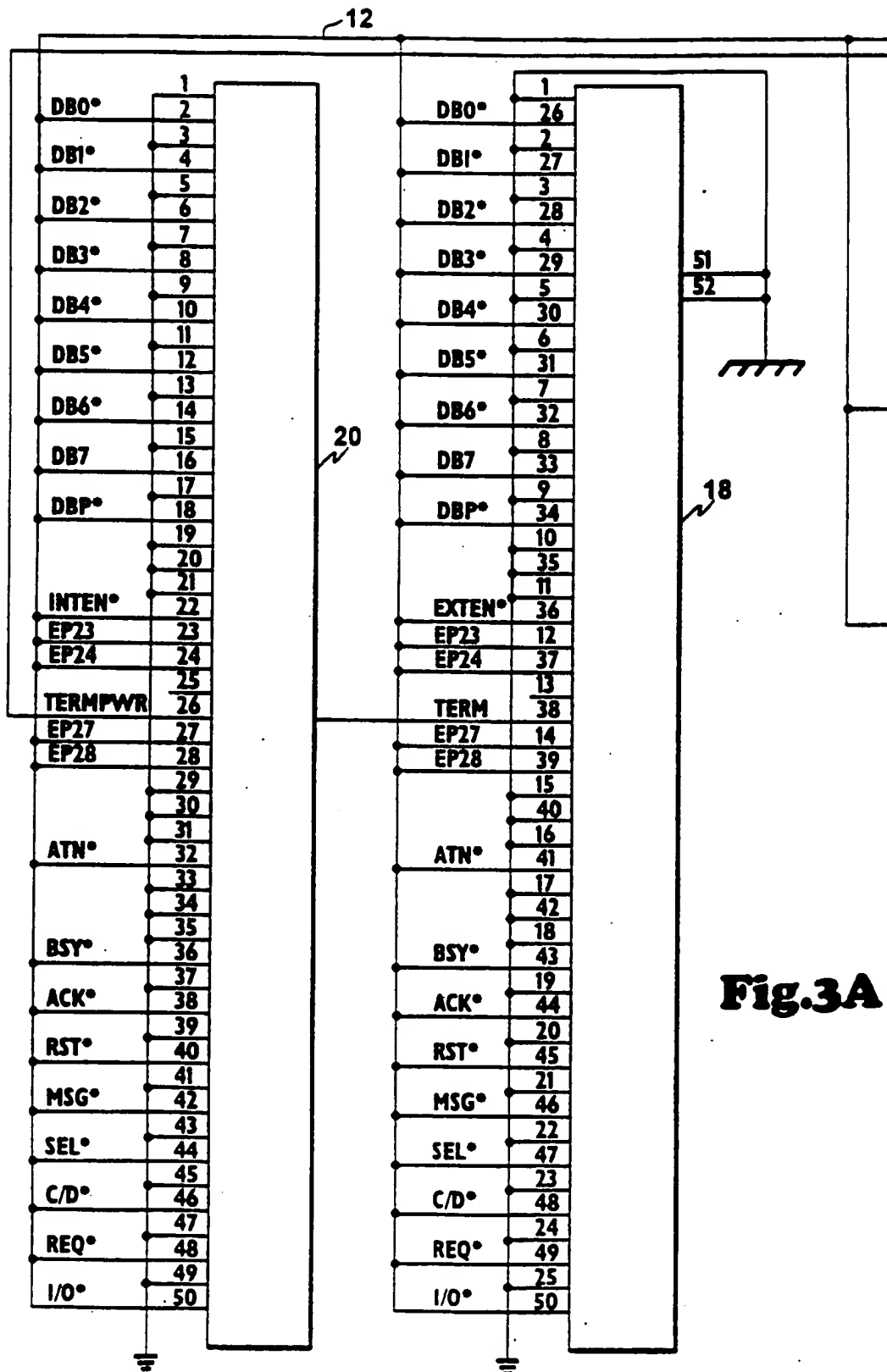
13 connected to ground and the other output connected to
14 said active terminator circuit disconnect input; a
15 resistor connected between said power input and said
16 transistor control input and a resistor connected
17 between said power input and said active terminator
18 circuit disconnect input.

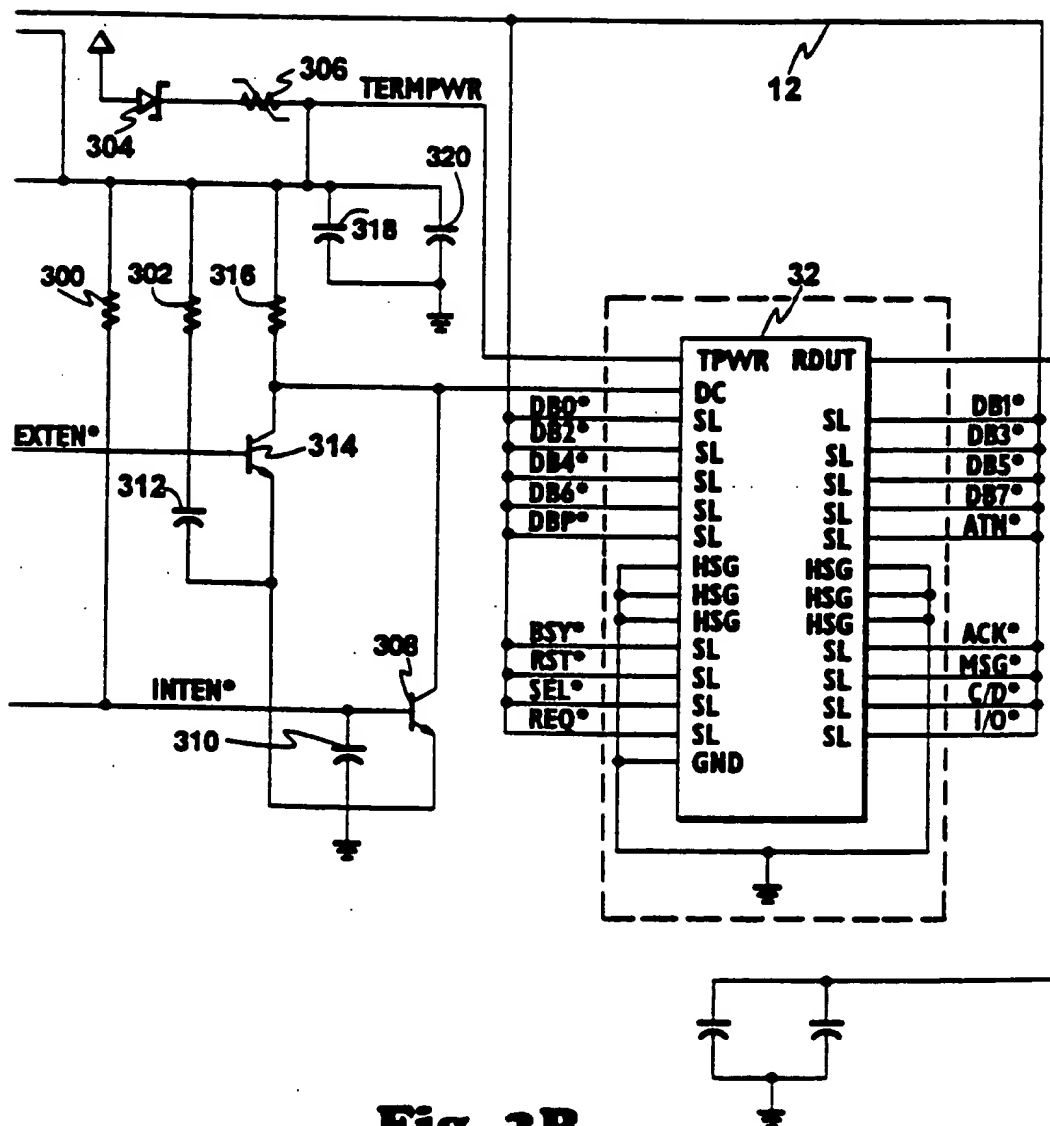
1 7. The apparatus of claim 6, wherein said
2 transistors are bipolar transistors.

1 8. The apparatus of claim 6, wherein said
2 transistors are MOSFET transistors.

1 9. The apparatus of claim 5, further comprising:
2 means connected to said first port and said
3 second port detecting means for allowing the device
4 connected status to be monitored by an external device.



**Fig. 3A**

**Fig. 3B**

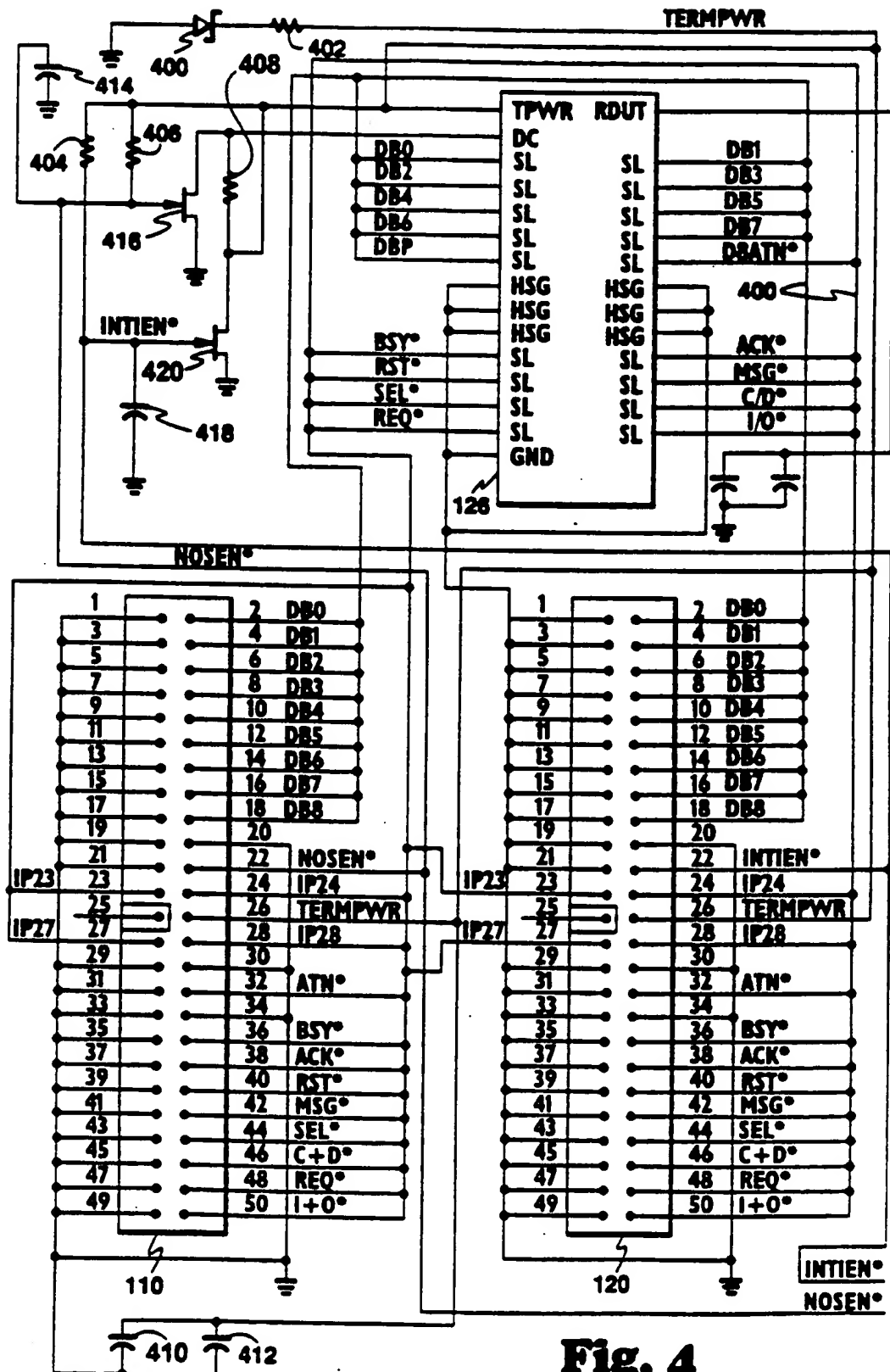
**Fig. 4**

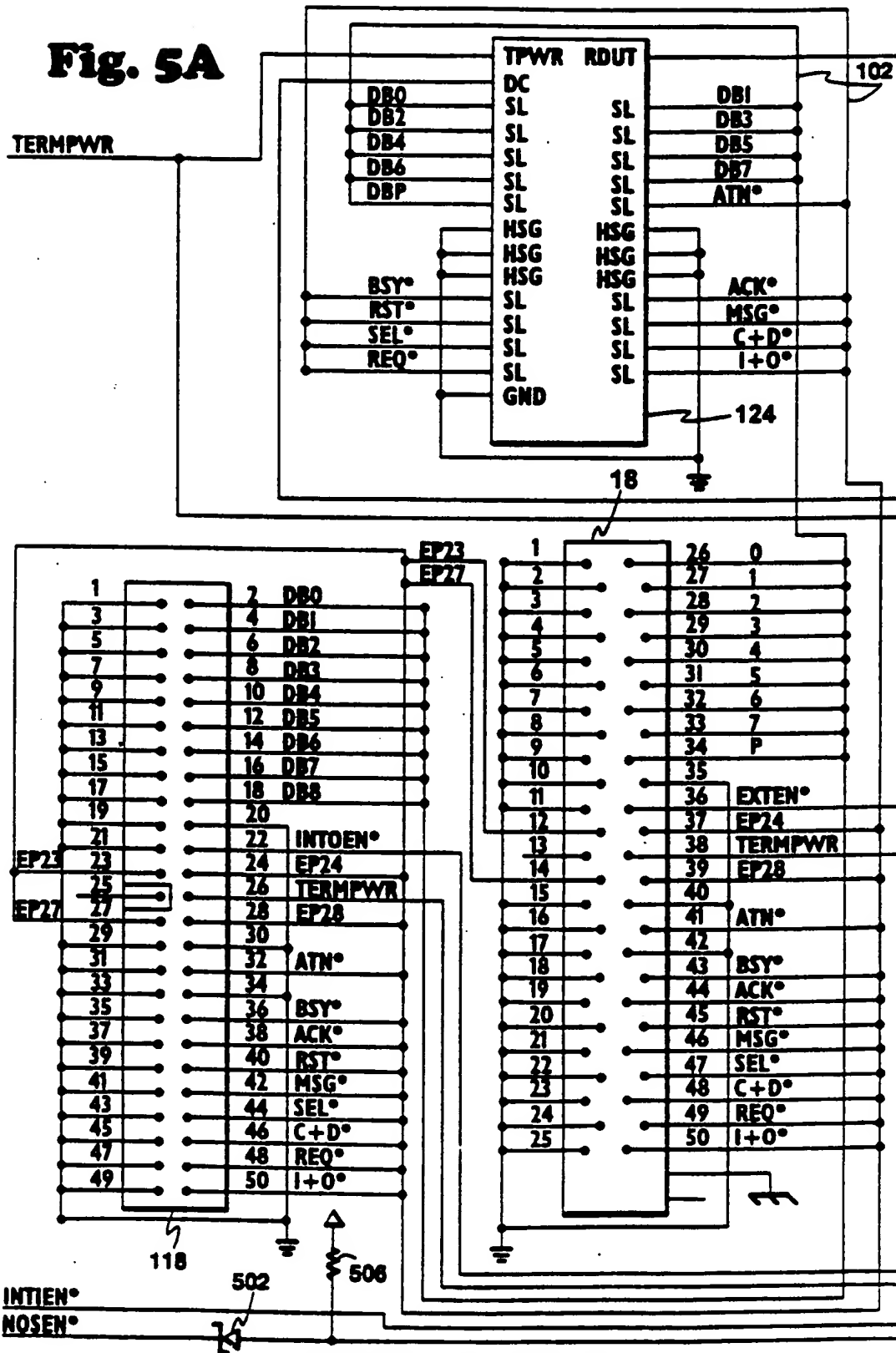
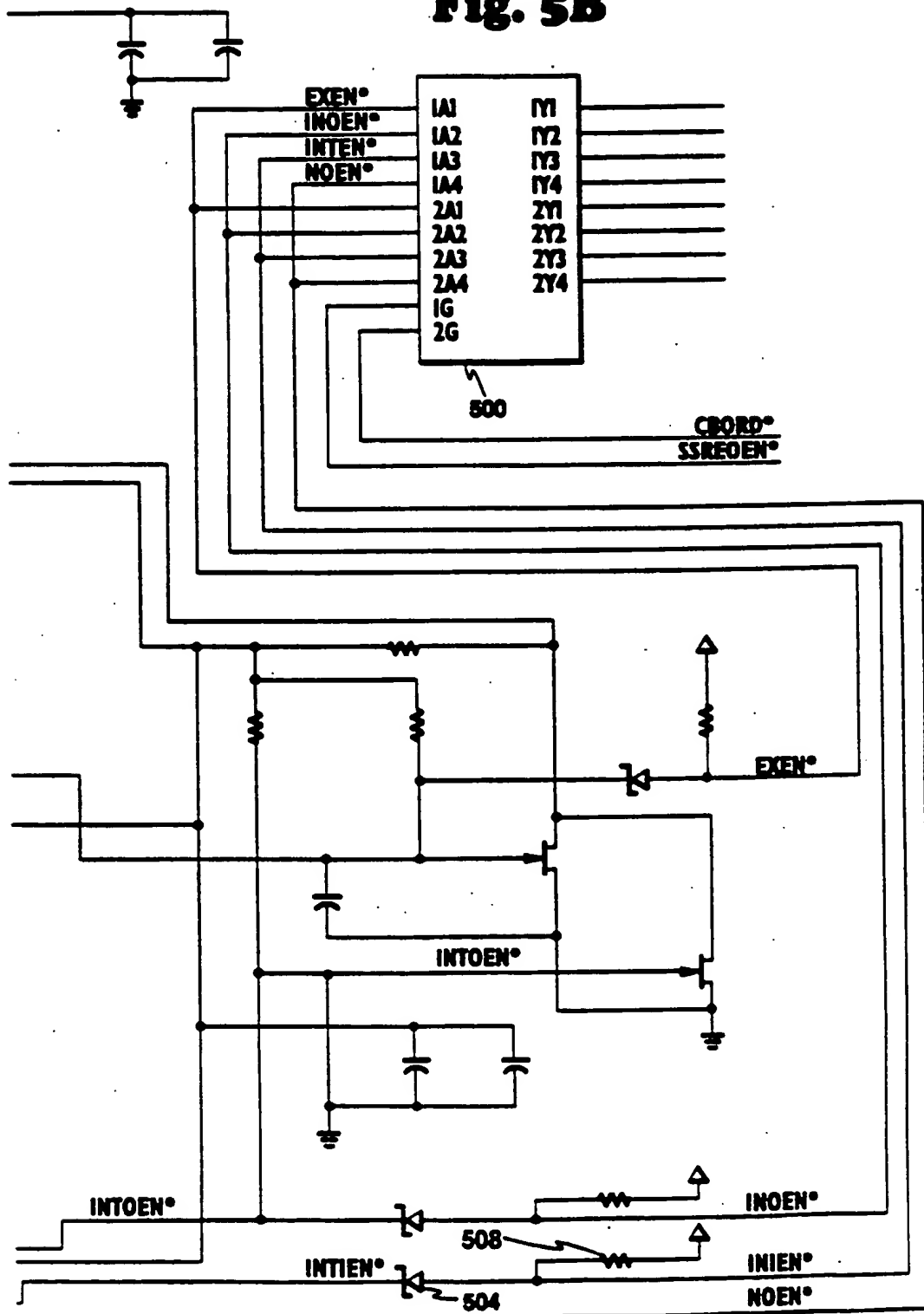
Fig. 5A

Fig. 5B

INTERNATIONAL SEARCH REPORT

Inter. Appl. Application No
PCT/US 93/09367

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 G06F13/40 H04L12/40

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 5 G06F H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 17, no. 19 (E-1306)13 January 1993 & JP,A,04 247 742 (FUJITSU LTD) 3 September 1992 see abstract	1-9
A	--- PATENT ABSTRACTS OF JAPAN vol. 15, no. 148 (E-1056)15 April 1991 & JP,A,03 023 706 (NEC CORP) 31 January 1991 see abstract	1-9
A	--- PATENT ABSTRACTS OF JAPAN vol. 15, no. 135 (E-1052)4 April 1991 & JP,A,03 016 445 (FUJITSU LTD) 24 January 1991 see abstract	1-9
	--- -/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

31 January 1994

Date of mailing of the international search report

- 2. 03. 94

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 93/09367

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,5 120 909 (KUTZ ET AL.) 9 June 1992 see the whole document ---	1-9
A	US,A,4 920 339 (FRIEND ET AL.) 24 April 1990 see column 3, line 54 - column 4, line 11; figures 1,2 -----	1-9

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. .onal Application No

PCT/US 93/09367

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-5120909	09-06-92	NONE	
US-A-4920339	24-04-90	NONE	